

# Prevalence of the Palmaris Longus Muscle in Indian American Population through Clinical Evaluation

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## SUMMARY

**Background.** The variability in the prevalence of Palmaris longus (PL) agenesis has been well-documented in various ethnic groups and populations. Lamentably, there is no previous study in the literature has reported the prevalence of PL agenesis in the Indian American population. This study aimed to determine the prevalence of PL agenesis and its association with gender, body side and hand dominance in the Indian American population.

**Methods.** In this cross-sectional study, a total of 600 subjects (300 males and 300 females) belonging to 18-45 years were accessed for the presence or absence of PL tendon, using a series of clinical tests. The association between the prevalence of PL agenesis and gender, limb laterality and hand dominance were determined by the Chi-square test. Overall agenesis of PL reached 15.33%, and unilateral agenesis (8%) was more common than bilateral absence (7.33%).

**Results.** The PL agenesis was found lesser ( $p = 0.037$ ) in females (14.33%) than the males (16.33%). The PL agenesis was significantly more often on the left side than the right ( $p = 0.02$ ). In right-hand dominant subjects, the left-sided agenesis was significantly more common ( $p = 0.014$ ) and in left-hand dominant subjects, the right-sided agenesis was greater ( $p > 0.05$ ).

**Conclusions.** Palmaris longus tendon agenesis in Indian American subjects was more analogous to the standard textbooks of hand surgery, but much higher than the other Asian and African populations. This comparison confirms that the prevalence of PL is race-dependent. The present study data may be valuable for tissue banks for harvesting the PL tendon allografts from Indian Americans which could be useful for surgeons during various reconstructive and tendon grafting surgery in Indian American patients.

## KEY WORDS

*Palmaris longus; Indian American population; agenesis; hand dominance; gender.*

## INTRODUCTION

Palmaris longus muscle is an important anatomical landmark of the superficial flexor compartment of the forearm, which is regularly used in clinical practice and surgical procedures. It originates as a short fusiform belly from the medial epicondyle of the humerus with supplementary inputs

from intermuscular septa and antebrachial fascia. In the mid-forearm, it toggles into a long slender tendon between the flexor carpi radialis and flexor carpi ulnaris and passes superficially over the median nerve and distally PL continues as a palmar aponeurosis (1). Comparative anatomical analysis reveals the phylogenetic regression of PL in other

primate's relatives such as chimpanzees, gorillas and humans due to non-adaptive evolution (2). Subjected to functional evolutionary influence the muscle often displays anatomical variations in humans; the most common is unilateral or bilateral agenesis. When present, PL can be digastric, bifid, duplicated or have anomalous insertion (3). Palmaris longus variations may manifest clinically with a forearm compartment syndrome or symptoms of compression of the median nerve in the carpal tunnel or entrapment of the ulnar nerve in the Guyon's tunnel (4, 5). Most surgeons use PL as an ideal donor tendon in orthopedic and reconstructive surgery as it fulfills the requirements of length, thickness and availability. Additionally, since it is superficial in position it is easily harvested without any disservice to hand movements (6). Various studies were done on different populations have established that there is a wide variation in the prevalence of PL agenesis within the ethnic groups (7-30), but there are no data in the literature to date regarding the prevalence of PL agenesis in Indian American populations. The Asian Indians are the second-fastest growing ethnic groups in the United States (US). The present study data may be valuable for tissue banks for harvesting the PL tendon as allografts from Indian Americans which could be useful for surgeons during various reconstructive and tendon grafting surgery in American patients. This study aimed to establish the prevalence of PL agenesis in the Indian American population and secondarily to evaluate its association with gender, side of the limb and hand dominance.

## MATERIALS AND METHODS

### Study design

A cross-sectional study was conducted to investigate the prevalence of PL agenesis in the Indian American population and secondarily to evaluate its association with gender, side of the limb and hand dominance using a series of clinical tests.

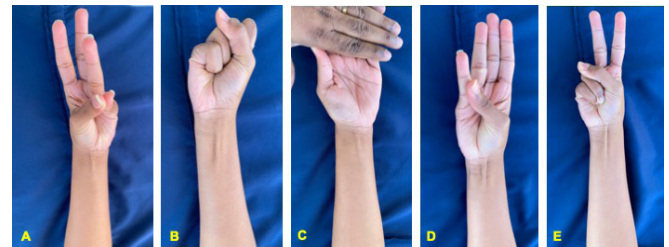
### Subjects

A total of 600 Indian American medical students (300 males and 300 females) aged between 17 and 45 years were examined for the presence or absence of PL tendon, using the conventional tests. The present study was approved by the Ethics Committee of the American University of Antigua, College of Medicine, Antigua (Ethics Committee approval number: ECAUA/05/2016). The authors of this study have followed the international ethical principles as well as the ethical standards of Helsinki.

Demographic data was obtained informational sheet, including age, sex, race, and place of birth, and parental heritage. Subjects who had a history of injury, surgery and any physical disabilities of upper limbs were excluded from the study.

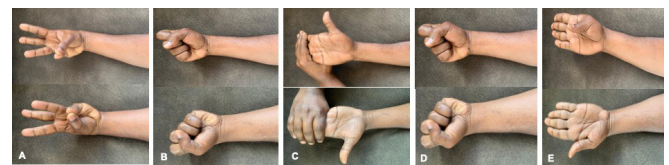
### Clinical test procedures

The examination process was explained thoroughly and informed consent was obtained from the subjects. First, the subjects were asked to perform the standard test (Schaeffer's test) on both hands which involved opposition of the thumb to the little finger and then flexing the wrist (**figure 1 A**). The presence of the palmaris tendon was visible as prominence on the volar aspect of the distal forearm were palpated. If the tendon was not visible or palpable, then the following four additional tests were carried out to confirm the absence. Thompson's test: the subject was asked to make a fist, then flex the wrist and finally the thumb was opposed and flexed over the fingers (**figure 1 B**). Mishra's test I: the metacarpophalangeal joints of all fingers were passively hyperextended by the examiner and the subject was asked to actively flex the wrist (**figure 1 C**). Mishra's test II: the subject was asked to abduct the thumb against resistance with the wrist in slight palmar flexion (**figure 1 D**). Pushpakumar's "two-finger sign" test: the subject was



**Figure 1.** Clinical test's demonstrating the presence of Palmaris longus tendon.

(A) Standard test (Schaeffer's test); (B) Thompson's test; (C) Mishra's test I; (D) Mishra's test II; (E) Pushpakumar's "two-finger sign" test.



**Figure 2.** Clinical test's demonstrating the bilateral absence of Palmaris longus tendon.

(A) Standard test (Schaeffer's test); (B) Thompson's test; (C) Mishra's test I; (D) Mishra's test II; (E) Pushpakumar's "two-finger sign" test.

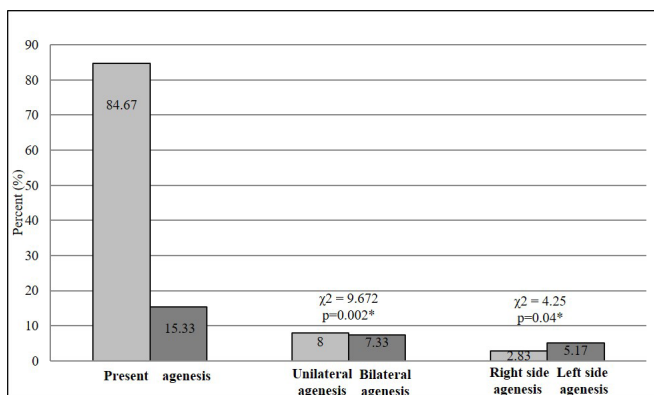
asked to fully extend the index and middle finger; the wrist and other fingers were flexed and finally the thumb was fully opposed and flexed (figure 1 E). Every clinical examination was done thrice by the same observer for conformity. Finally, the absence of the PL tendon was recorded on both sides of the forearm (figure 2).

### Statistical analysis

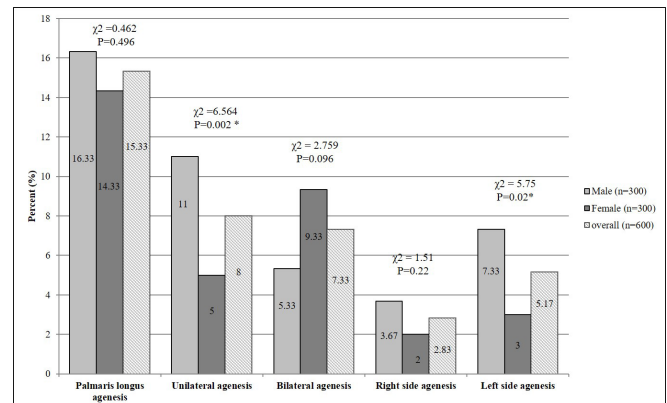
The data were analyzed using SPSS software (version 11.5) and were presented in percentage values. The prevalence of PL tendon agenesis and its association with gender, limb laterality and hand dominance were analyzed by the Chi-square test, with values of  $p < 0.05$  considered significant.

## RESULTS

The overall prevalence of PL agenesis (unilateral and bilateral) was found in 92 (15.33%) out of 600 subjects (figure 3), agenesis of PL was greater in males [49 (16.33%)] than the females [43 (14.33%)], with no significant differences ( $p = 0.49$ ) (figure 4). It was absent bilaterally in 44 (7.33%) subjects [16 (5.33%) males and 28 (9.33%) females] and unilateral absence was found in 48 (8%) subjects [33 (11%) males and 15 (5%) females] with statistically significant difference ( $p = 0.002$ ) (figure 3). The unilateral absence of PL was significantly ( $p = 0.002$ ) greater in male [33(11%)] than the female [15(5%)]. The bilateral absence of PLM was greater in females [28(9.33%)] than the male [16(5.33%)], with no significant difference ( $p = 0.09$ ) (figure 4).



**Figure 3.** The column bar graph shows the overall distribution of Palmaris longus tendon agenesis.  $\chi^2$ : Chi squared; P-value; \*significantly different.



**Figure 4.** The column bar graph shows the sex distribution of Palmaris longus tendon agenesis.  $\chi^2$ : Chi squared; P-value; \*significantly different.

Unilateral absence of the palmaris longus muscle was significantly higher ( $p = 0.04$ ) in the left hand [31 (5.17%) subjects] than in the right hand [17 (2.83%) subjects] (figure 3). The PL absence in the left hand was significantly ( $p = 0.02$ ) greater in males [22 (7.33%)] than the female subjects [9 (3%)] and in the right hand also the PL absence was greater in male's [11 (3.67%)] than the female subjects [6 (2%)]. However, no significant sex differences ( $p = 0.22$ ) were observed (figure 4).

We observed that 573 (95.5%) subjects had right-hand dominance while 27 (4.5%) persons had left-hand dominance (table I). The subjects with left-hand dominance had higher agenesis of PL (16.7%) when compared with the right-hand dominant (11.1%). However, the result shows no significant difference. In both right and left-hand dominant subjects, the agenesis of PL was more common in the non-dominant hand. In right-hand dominant subjects, PL was absent on the left side 30 (5.24%) was significantly ( $p = 0.014$ ) greater than on the right side 14 (2.44%), whereas in left-hand dominant subjects PL absence was greater in the right side in 3 (11.1%) than the left side in 1 (3.7%) subject, but the difference was not statistically insignificant ( $p < 0.05$ ). Therefore, the right-sided absence was significantly more common ( $p < 0.001$ ) in left-hand dominant subjects than in right-hand dominant subjects. Left-sided absence was more common in right-hand dominant subjects than in left-hand dominant and the difference was not significant ( $p < 0.05$ ) (table II).

## DISCUSSION

The total rate of PL agenesis (15.33%) in Indian Americans was very much similar to the values (15%) in stan-

**Table I.** Association between overall PL agenesis and hand dominance.

PL	Hand dominance		Chi -square	P-value
	Right	Left		
Agenesis	86 (15%)	6 (22.22%)	1.0335	0.3093
Present	487 (85%)	21 (77.78%)		
Overall	573 (95.5%)	27 (4.5%)		

PL: Palmaris longus; \*significant different.

**Table II.** Association between laterality of PL agenesis and hand dominance.

PL agenesis	Hand dominance		Chi -square	P-value
	Right (n = 573, 95.5%)	Left (n = 27, 4.5%)		
Right side	14 (2.44%)	3 (11.11%)	7.037	0.008*
Left side	30 (5.24%)	1 (3.7%)	0.1234	0.7253
Chi -square	6.05049	1.08		
P-value	0.014*	0.2987		

PL: Palmaris longus; \*significant different.

standard textbooks of hand surgery (2) and the Ethiopian population (7). In contrast, this value was comparable to the highest absence rate in Middle Eastern populations (8-12) and followed by Caucasians (6, 13), whereas the lowest absence rate was in black (14-18) and Chinese Asian populations (19). When compared to studies done on Indian populations, the PL absence rate was lower than the South Indian (32%) and Indian populations (20, 21), but higher compared to Indian Malaysian (9.3%) (22), which reaffirms the marked variation in different ethnic groups (**table III**). Our results indicate that this tendon is still commonly available, with regard to the Indian Americans.

Apart from ethnic variations in the PL agenesis, it is been often debated in the literature regarding the association of gender, laterality and side with the PL agenesis. The overall prevalence of PL agenesis in the Indian Americans was significantly greater in males (16.33%) than the females (14.33%). In consistent to our study, different studies reported a higher absence rate in males, but no sex difference was observed (6, 13, 16, 17, 19, 21). In contrast, majority of studies reported that agenesis was significantly more common in females (7-12, 14, 15, 18, 22-27).

In favorable of our study, most of the clinical studies done on black (7, 14, 16-18), Asian (19-25) and Caucasian populations (13, 26, 27) reported that the unilateral agenesis of

**Table III.** Comparison of the association of PL agenesis and hand dominance of the present study results with other studies using clinical tests.

Authors	N	Year	Population	PL absence						Total (%)
				Unilateral (%)		Bilateral (%)		Overall (%)		
				M	F	M	F	M	F	
Thompson <i>et al.</i> (6)	300	2001	Caucasian	19.3	13.3	10	7.3	29.3	20.6	25
Berhe <i>et al.</i> (7)	712	2014	Ethiopian	6.9	7.7	7.4	10.1	14.3	17.8	15.3
Sater <i>et al.</i> (8)	1043	2010	Bahrain	17.8	17.9	16.2	21.3	34	39.2	36.8
Jashni <i>et al.</i> (9)	732	2014	Iran	9.1	13.2	13.5	25.4	22.7	38.6	30.7
Raouf <i>et al.</i> (10)	386	2013	Egyptian	21.9	19.7	26.8	32.8	41	54.74	50.8
Ceyhan and Mavt (11)	7000	1997	Turkey	19.5	22.9	42.1	45.3	61.6	68.3	63.91
Kose <i>et al.</i> (12)	1350	2009	Turkey	9.03	13.62	11.7	18.37	20.74	32.44	26.59
Eric <i>et al.</i> (13)	800	2010	Serbia	18.5	22.25	18.5	13.3	39.5	35.5	37.5

Authors	N	Year	Population	PL absence						Total (%)
				Unilateral (%)		Bilateral (%)		Overall (%)		
				M	F	M	F	M	F	
Offei <i>et al.</i> (14)	210	2014	Ghana	2.1	4.7	0.7	1.6	2.7	6.3	3.8
Osonuga <i>et al.</i> (15)	226	2012	Ghanaian	1.3	1.36	0	0.44	1.3	1.8	3.1
Kigera <i>et al.</i> (16)	800	2011	East African	3.6	3	1.3	1	4.9	3.9	4.4
Mbaka <i>et al.</i> (17)	600	2009	Nigerian	5.4	6	1.5	0.4	6.9	6.4	6.7
Gangata <i>et al.</i> (18)	890	2009	Zimbabwe	0.33	0.56	0.22	0.33	0.56	0.9	1.46
Sebastin <i>et al.</i> (19)	329	2006	Singaporean Chinese	3.8	2.5	1	1.7	8.3	2.4	4.6
Venkatapathy <i>et al.</i> (20)	300	2021	South Indian	16	29	4	14	21	43	32
Kapoor <i>et al.</i> (21)	500	2008	Indian	12.71	6.06	5.08	10.06	17.8	16.67	17.2
Roohi <i>et al.</i> (22)	450	2007	Malaysian	5.8	7.1	1.3	4.4	7.1	11.5	9.3
Yong <i>et al.</i> (23)	1239	2017	Malay	6.08	9.77	3.04	4.4	9.1	14.2	11.7
Sharma <i>et al.</i> (24)	270	2019	Nepalese	11.2	11	3.2	4.1	14.4	15.2	14.8
Lamichhane <i>et al.</i> (25)	503	2017	Filipino	12.94	15.3	0.4	2.58	4.77	12.72	17.5
Nilton Alves <i>et al.</i> (26)	200	2011	Chilean	10.46	11.4	6.97	10.52	17.44	21.93	20
Morais <i>et al.</i> (27)	740	2012	Brazilian	10.3	16.7	13.1	10.7	21.1	29.7	26.5
Present study	600	2021	Indian American	11.00	5.00	5.33	9.33	16.33	14.33	15.33

N: Number subjects; PL: Palmaris longus; M: Male; F: Female.

PL muscle as being more common than bilateral agenesis. In contrast, different studies done on Middle Eastern populations reported greater bilateral absence (8-12). In Indian American population, the males had significantly greater unilateral agenesis and the females had significantly greater bilateral agenesis, this is in agreement with Kapoor *et al.* study on the Indian Population. Sater *et al.* (8) in Bahrain, Karimi *et al.* (9) in the Iranian population found significantly greater bilateral absence in females, however, unilateral absence showed no sex significance. Alternatively, Mkaba *et al.* (17) in the Nigerian population reported a significantly higher bilateral agenesis rate in males.

Some authors have reported the incidence of agenesis to be significantly higher in female subjects and on the left side (8, 9, 12, 13, 21). In total disagreement, our data have demonstrated a higher overall prevalence of unilateral absence of the palmaris longus muscle in males on both right and left hand. However, the significant difference was observed only on the left side. Yong *et al.* in Malays also described the unilateral left-side agenesis was significantly higher in males (23). On the other hand, Abledu *et al.* (14) in Ghana population observed that right-side agenesis was significantly more common in females.

About hand dominance, the PL agenesis was greater in subjects with left hand dominant than the right hand dominant, but no significant difference was observed. Our result was similar to the prior studies done on Ethiopian (7), Ghana (14) and Malay (19) population. The agenesis of PL was significantly more common on the non-dominant hand in both right and left-handed subjects. This finding suggests that the dominant hand is more involved in manual work and therefore it is less likely to degenerate compared to the non-dominant hand. In right-hand dominant subjects, the agenesis of PL was significantly greater on the left side than on the right side, which correlated perfectly with reports of Kigera *et al.* (16), Eric *et al.* (28) and Ranjib Jha *et al.* (29). In left-hand dominant subjects, the agenesis of PL was greater on the right hand which was similar to the results of Ranjib Jha *et al.* (29). Even though, Eric *et al.* also observed similar results, but they noted a significant difference (28). In contrast, Jashni *et al.* (9) found the PL agenesis was equal on both sides in left-hand dominant subjects, while Kigera *et al.* (16) found no agenesis on the right side (table IV) (31). In disagreement with other studies, Garcia *et al.* in the Brazilian population found both right and left-handed subjects had a higher percentage of PL agenesis on the left side (30).



**Table IV.** Comparison of the association of Palmaris longus agenesis and hand dominance of the present with other studies using clinical tests.

Author	Year	N	Population	Right handed		Left handed	
				Right PL agenesis (%)	Left PL agenesis (%)	Right PL agenesis (%)	Left PL agenesis (%)
Jashni <i>et al.</i> (9)	2014	732	Iran	27 (4.1)	44 (6.6)	4 (6.5)	4 (6.5)
Kigera <i>et al.</i> (16)	2011	800	East African	7 (0.9)	17 (2.3)	0 (0)	1 (2.5)
Eric <i>et al.</i> (28)	2010	800	Serbia	24 (5.3)	50 (11.1)	18 (20)	2 (2.2)
Jha <i>et al.</i> (29)	2015	400	Eastern Nepalese	6 (1.6)	23 (6)	3 (18.7)	1 (6.3)
Qa'oud <i>et al.</i> (31)	2019	700	Egyptian	72 (10.7)	60 (8.9)	1 (3.6)	2 (7.1)
Present study	2021	600	Indian Americans	14 (2.44)	30 (5.24)	3 (11.11)	1 (3.7)

N: Number subjects; PL: Palmaris longus.

A shortcoming of our study was that it is challenging to assess all the variation PL muscle using clinical tests. Rarely, it may lead to misinterpretation of an inadequately developed muscle or anomalous tendon as absent. These variations can be precisely determined by MRI and Ultrasonography, but lamentably it is difficult to perform this investigation in a large number of subjects because it is neither cost-effective nor time-saving. Hence the clinical test remains the only feasible method for documenting the presence or absence of this tendon in such large-scale population studies (12, 28, 32).

## CONCLUSIONS

The palmaris longus tendon agenesis in Indian American subjects was more analogous to the standard textbooks of hand surgery and the previous study on the Ethiopian population. The values are comparable to a much higher prevalence of PL agenesis in the Middle East to the lowest in the African population. This comparison confirms that the prevalence of palmaris longus is race-dependent. The present study data may be valuable for tissue banks for harvesting the tendon allografts from Indian Americans which could be useful for surgeons during various recon-

structive and tendon grafting surgery in Indian American patients.

## FUNDINGS

The study was funded by the American University of Antigua (AUA), Antigua, West Indies.

## DATA AVAILABILITY

Data are available to the following repository link: <https://www.dropbox.com/sh/u6eao7n8trwq2yc/AADEeYm8U2bl3nfHDhbl7Gpea?dl=0>.

Authors agreed for data publication.

## CONTRIBUTIONS

CMS: data collection. CMS, VP: writing the manuscript, data analysis and revision of the manuscript.

## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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